REMARKS

Claims 1 – 15 are pending in this application. By the Amendment, claims 1 – 15 have been amended. Applicant respectfully submits that no new matter has been added. It is believed that this response is fully responsive to the Office Action dated March 29, 2002.

New Matter Objection:

The amendment filed on January 28, 2002 is objected to under 35 U.S.C. §132 because it introduces new matter into the disclosure. 35 U.S.C. §132 states that no amendment shall introduce new matter into the disclosure of the invention. The added material which is not supported by the original disclosure is as follows: claims 1, 6 and 11 have been amended to include the term "⌀ " that is not supported by the specification. The specification has used the symbol "φ" to designate a "rational position" but does not disclose "⌀ " to denote rational position or anything.

Claims 1, 6, and 11 have been amended to include the symbol "ϕ" which is supported by the specification as originally filed. Accordingly, withdrawal of this objection is respectfully solicited.

35 U.S.C. §112, First Paragraph Rejection:

Claims 1-5 and 6-10 and 11-15 are rejected under 35 U.S.C. §112, first paragraph, as containing subject matter which was not described in the specification in such a way as to reasonably convey to one skilled in the relevant art that the inventor(s), at the time the

application was filed, had possession of the claimed invention. The reasons for rejection based on the newly added subject matter are set forth in the paragraph above.

This rejection is respectfully traversed.

As discussed above, claims 1, 6 and 11 have been amended to include "ϕ" which is supported by the specification as originally filed. Accordingly, withdrawal of this rejection is respectfully solicited.

35 U.S.C. §112, Second Paragraph Rejection:

Claims 1-5 and 6-10 and 11-15 are rejected under 35 U.S.C. §112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention. The reasons for rejection are set forth in the previous Office Action dated September 26, 2001.

This rejection is respectfully traversed.

Claims 1-15 have been amended to overcome the rejection under 35 U.S.C. §112, second paragraph. Accordingly withdrawal of this rejection is respectfully solicited.

As to the Merits:

As to the merits of this case, the Examiner maintains the following rejection:

claims 1 and 6 stand rejected under 35 U.S.C. §103(c) as being unpatentable over Hasegawa (of record) in view of Ohkura et al. (of record).

This rejection is respectfully traversed.

The Examiner contends that the hologram fringes patters of Hasegawa have grooves structure. It is negated by the description and drawing Fig. 74(a) is apparently a cross-section of the rotatable hologram, which shows no grooves. In the description at col. 53, lines 33-36, the rotatable hologram is manufactured using the interference of the object wave and the reference wave. An interference of plane waves (col. 53, line 38) cannot produce grooves but plane fringe patterns on the surface.

Another important point the Examiner neglects is that the rotatable hologram of Hasegawa deflects a light beam, or it transmits light, but does not reflect light. The diffraction Not claimed. grating of the present invention is a reflection type because the profile of the grooves is critical to the wavelength of the diffracted light. In the transparent type grating as Hasegawa's, what is important is the spatial frequency, as Hasegawa repeatedly stresses from col. 52, line 39 to col. 54, line 12, and not the profile of the grooves. Thus the most important difference between Hasegawa's and the present invention is that the grating of the present invention relates to the profile, while Hasegawa relates to the spatial frequency, of the grating.

In view of the aforementioned amendments and accompanying remarks, claims 1 - 15 , as amended, are in condition for allowance, which action, at an early date, is requested.

If, for any reason, it is felt that this application is not now in condition for allowance, the Examiner is requested to contact Applicant's undersigned attorney at the telephone number indicated below to arrange for an interview to expedite the disposition of this case.

Attached hereto is a marked-up version of the changes made to the Claims by the current amendment. The attached page is captioned "**Version with markings to show changes made**."

In the event that this paper is not timely filed, Applicant respectfully petitions for an appropriate extension of time. Please charge any fees for such an extension of time and any other fees which may be due with respect to this paper, to Deposit Account No. 01-2340.

Respectfully submitted,

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VERSION WITH MARKINGS TO SHOW CHANGES MADE 09/642,883

IN THE CLAIMS:

Claims 1 through 15 have been AMENDED to read as follows:

1. (Twice Amended) A plane diffraction grating with grooves formed on a surface thereof, the plane diffraction [rating] grating being rotated about a rotational axis which is normal to the surface, and being characterized in that a profile of the grooves at a radial area is determined depending on a [rotational] azimuthal position [⌀]ϕ of the area about a rotational center defined as a foot of the rotational axis on the surface of the plane diffraction grating.

2. (Amended) The plane diffraction grating according to claim 1, wherein the plane diffraction grating is a blazed type, and a blaze angle θ_0 of the grooves in an area along an original line at the azimuthal angle $\phi = 0$ which is perpendicular to the grooves [rotational position $\varphi = 0$] is set as:

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where α is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and β is an angle of a diffraction ray from the normal, and
a blaze angle θ_φ of the grooves in an area along a line at the azimuthal [rotational] position [φ] is set as

$$\sin\theta_\phi = \sin\theta_0 \sqrt{\frac{1+\tan^2\phi}{1+\tan^2\phi\sin^2\theta_0}}.$$

3. (Amended) The plane diffraction grating according to claim 2, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

[an] a unit thickness $db[0]_\phi$ of the multiple-layer coating in the area along the original line at the [rotational position ϕ= 0] azimuthal angle ϕ= 0 satisfies the equation:

$$m_b\lambda_{[0]} = 2d_{b[0]\phi}R_{\alpha[0]\phi}\cos(\alpha - \theta_0)$$

where

mb is the diffraction order,

$\lambda[_0]$ is the wavelength of the light diffracted by the area,

$$R_{\alpha[0]\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}\ ,$$

δ_ϕ= 1-n_ϕ,

n_ϕ is the average refractive index of the multiple-layer coating[,

and an unit thickness $d_{b\varphi}$ of the multiple-layer coating in the area along the line at the rotational position φ satisfies the equation:

$$m_b\lambda = 2d_{b\phi}R_{\alpha\phi}\cos(\alpha - \theta_0)\,,$$

where

λ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}\ ,$$

δ_φ=1- n_φ

$n_\varphi$is the average refractive index of the multiple-layer coating].

4. (Amended) The plane diffraction grating according to claim 1, wherein the plane

diffraction grating is a laminar type, and a depth h[0]$_{\underline{\Phi}}$of the grooves in an area along [an original] a̲ line at the [rotational position $\phi = 0$] azimuthal angle ϕ is set as

$$h_{[0]\underline{\phi}} = \frac{\lambda_{[0]}}{2(\cos\alpha + \cos\beta)},$$

where$\lambda_{[}$0] is the wavelength of the light diffracted by the area, α is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and β is an angle of a diffraction ray from the normal[, and

a depth $h\phi$ of the grooves in an area along a line at the rotational position ϕ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}].$$

5. (Amended) The plane diffraction grating according to claim 4, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

[an] a̲ unit thickness db[0]$_{\underline{\phi}}$of the multiple-layer coating in the area along the [original] line at the [rotational position φ = 0] azimuthal angle ϕ satisfies the equation:

$$m_b\lambda_{[0]} = d_{b[0]\underline{\phi}}(R_{\alpha[0]\underline{\phi}}\sin\alpha + R_{\beta[0]\underline{\phi}}\sin\beta),$$

where

mb is the diffraction order,

$$R_{\alpha[0]\underline{\phi}} = \sqrt{1-(2\delta_{\underline{\phi}} - \delta_{\underline{\phi}}{}^2)/\cos^2\alpha}, \quad R_{\beta[0]\underline{\phi}} = \sqrt{1-(2\delta_{\underline{\phi}} - \delta_{\underline{\phi}}{}^2)/\cos^2\beta},$$

δ= 1- $n_{\underline{\Phi}}$,

$n_{\underline{\Phi}}$ is the average refractive index of the multiple-layer coating[,

and

an unit thickness $db\phi$ of the multiple-layer coating in the area along the line at the

rotational position φ satisfies the equation:

$$m_b \lambda = d_{b\phi}(R_{\alpha\phi} \sin \alpha + R_{\beta\phi} \sin \beta),$$

where

λ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2 \alpha}\,, \quad R_{\beta\phi} = \sqrt{1-(2\delta_\phi - \delta_\phi^2)/\cos^2 \beta}\,,$$

$\delta_\varphi = 1\ n_\varphi$,

n_φ is the average refractive index of the multiple-layer coating].

6. (Twice Amended) An optical system comprising:

a plane diffraction grating having grooves on a surface of the plane diffraction grating whose profile at an area is determined depending on a [rotational] azimuthal position [ø] ϕ of the area about a rotational center defined as a foot of a rotational axis which is normal to the surface;

a mechanism for rotating the plane diffraction grating about the rotational axis~~;~~

an incidence optical system for casting a converging beam of light on a point of the surface of the plane diffraction grating, the point being apart from the rotational center.

7. (Amended) The optical system according to claim 6, wherein the plane diffraction grating is a blazed type, and a blaze angle $\theta 0$ of the grooves in an area along an original line at the azimuthal angle ϕ=0 which is perpendicular to the grooves [rotational position φ = 0] is set as:

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where α is an angle of an incident ray from a normal to the surface of the plane diffraction

grating in the area, and β is an angle of a diffraction ray from the normal, and

a blaze angle θ_φ of the grooves in an area along a line at the azimuthal [rotational] position [φ] ϕ is set as:

$$\sin\theta_\phi = \sin\theta_0\sqrt{\frac{1+\tan^2\phi}{1+\tan^2\phi\sin^2\theta_0}}.$$

8. (Amended) The optical system according to claim 7, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

[an] a unit thickness $db[_0]_\phi$ of the multiple-layer coating in the area along the original line at the [rotational position $\phi = 0$] azimuthal angle $\phi = 0$ satisfies the equation:

$$m_b\lambda_{[0]} = 2d_{b[0]\phi}R_{\alpha[0]\phi}\cos(\alpha-\theta_0),$$

where

mb is the diffraction order,

$\lambda[_0]$ is the wavelength of the light diffracted by the area,

$$R_{\alpha[0]\phi} = \sqrt{1-(2\delta_\phi-\delta_\phi{}^2)/\cos^2\alpha},$$

$\delta_\phi = 1 - n_\phi,$

n_ϕ is the average refractive index of the multiple-layer coating[,

and

an unit thickness db_φ of the multiple-layer coating in the area along the line at the rotational position φ satisfies the equation:

$$m_b\lambda = 2d_{b\phi}R_{\alpha\phi}\cos(\alpha-\theta_0),$$

where

λ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}\ ,$$

$\delta_\varphi = 1 - n_\varphi$,

n_φ is the average refractive index of the multiple-layer coating].

9. (Amended) The optical system according to claim 6, wherein the plane diffraction grating is a laminar type, and a depth $h0$ of the grooves in an area along an original line at the [rotational position $\varphi = 0$] azimuthal angle ϕ is set as

$$h_{[0]\underline{\phi}} = \frac{\lambda_{[0]}}{2(\cos\alpha + \cos\beta)},$$

where $\lambda[_0]$ is the wavelength of the light diffracted by the area, α is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and β is an angle of a diffraction ray from the normal[, and

a depth h_φ of the grooves in an area along a line at the rotational position ϕ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}.]$$

10. (Amended) The optical system according to claim 9, wherein:

the surface of the plane diffraction grating is covered with a multiple-layer coating to improve reflectivity;

[an] a unit thickness $d\ b[_0]_{\phi}$ of the multiple-layer coating in the area along the [original] line at the [rotational position $\phi = 0$] azimuthal angle ϕ satisfies the equation:

$$m_b\lambda_{[0]} = d_{b[0]\underline{\phi}}(R_{\alpha[0]\underline{\phi}}\sin\alpha + R_{\beta[0]\underline{\phi}}\sin\beta)\ ,$$

where

mb is the diffraction order,

$$R_{\alpha[0]\underline{\phi}} = \sqrt{1-(2\delta_{\underline{\phi}} - \delta_{\underline{\phi}}{}^2)/\cos^2\alpha}\,, \quad R_{\beta[0]\underline{\phi}} = \sqrt{1-(2\delta_{\underline{\phi}} - \delta_{\underline{\phi}}{}^2)/\cos^2\beta}\,,$$

$\delta = 1\ n_{\underline{\phi}}$,

$n_{\underline{\phi}}$ is the average refractive index of the multiple-layer coating[,

and

an unit thickness $d_{b\varphi}$ of the multiple-layer coating in the area along the line at the rotational position ϕ satisfies the equation:

$$m_b\lambda = d_{b\phi}(R_{\alpha\phi}\sin\alpha + R_{\beta\phi}\sin\beta)\,,$$

where

λ is the wavelength of the light diffracted by the area,

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}\,, \quad R_{\beta\phi} = \sqrt{1-(2\delta_\phi - \delta_\phi^2)/\cos^2\beta}\,,$$

$\delta_\varphi = 1\ n_\varphi$,

$n\phi$ is the average refractive index of the multiple-layer coating].

11. (Twice Amended) A method of producing a plane diffraction grating having grooves on a surface thereof whose profile at an area is determined depending on a [rotational] azimuthal position [⌀] $\underline{\phi}$ of the area about a rotational center defined as a foot of a rotational axis, the method comprising the steps of:

coating a substrate with a photo-resist layer and forming a photo-resist mask from the photo-resist layer according to a preset pattern of groove arrangement;

covering the photo-resist mask with a sector mask having an opening of a narrow sector whose apex is set at the rotational center;

etching the substrate over the sector mask with an appropriate etching condition

depending on a rotational position of the sector mask about the rotational center;

rotating the sector mask by an angle of the apex of the narrow sector; and

repeating the etching process and the mask rotating process until the narrow sector sweeps the surface of the substrate.

12. (Amended) The plane diffraction grating producing method according to claim 11, wherein the plane diffraction grating is a blazed type, and the etching condition in the etching process is such that:

a blaze angle $\theta 0$ of the grooves in an area along an original line at the <u>azimuthal angle $\phi = 0$ which is perpendicular to the grooves</u> [rotational position $\varphi = 0$] is set as

$$\theta_0 = \frac{\alpha + \beta}{2},$$

where α is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and β is an angle of a diffraction ray from the normal, and

a blaze angle $\theta\phi$ of the grooves in an area along a line at the [rotational] <u>azimuthal</u> position ϕ is set as

$$\sin\theta_\phi = \sin\theta_0 \sqrt{\frac{1 + \tan^2\phi}{1 + \tan^2\phi \sin^2\theta_0}}$$

13. (Amended) The plane diffraction grating producing method according to claim 12, wherein the surface of the plane diffraction grating is then covered with a multiple-layer coating to improve reflectivity, and:

[an] <u>a</u> unit thickness $db[0]_\phi$ of the multiple-layer coating in the area along the original line at the [rotational position $\varphi = 0$] <u>azimuthal angle $\phi = 0$</u> satisfies the equation:

$$m_b\lambda_{[0]} = 2d_{b[0]\underline{\phi}}R_{\alpha[0]\underline{\phi}}\cos(\alpha - \theta_0),$$

where

mb is the diffraction order,

$\lambda[_0]$is the wavelength of the light diffracted by the area,

$$R_{\alpha[0]\underline{\phi}} = \sqrt{1-(2\delta_{\underline{\phi}}-\delta_{\underline{\phi}}^{2})/\cos^2\alpha},$$

δ_ϕ= 1-$n_{\underline{\phi}}$,

$n_{\underline{\phi}}$ is the average refractive index of the multiple-layer coating[,

and

an unit thickness $d_{b\varphi}$ of the multiple-layer coating in the area along the line at the rotational position φ satisfies the equation:

$$m_b\lambda = 2d_{b\phi}R_{\alpha\phi}\cos(\alpha - \theta_0),$$

where

λ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi-\delta^2{}_\phi)/\cos^2\alpha},$$

$\delta\varphi$ = 1 $n\phi$,

$n\varphi$ is the average refractive index of the multiple-layer coating].

14. (Amended) The plane diffraction grating producing method according to claim 11, wherein the plane diffraction grating is a laminar type, and the etching condition in the etching process is such that:

a depth $h[_0]_{\underline{\phi}}$ of the grooves in an area along [an original] a line at the [rotational position φ= 0] azimuthal angle $\underline{\phi}$ is set as

$$h_{[0]\underline{\phi}} = \frac{\lambda_{[0]}}{2(\cos\alpha + \cos\beta)},$$

where$\lambda[_0]$ is the wavelength of the light diffracted by the area, α is an angle of an incident ray from a normal to the surface of the plane diffraction grating in the area, and β is an angle of a diffraction ray from the normal, [and

a depth $h\varphi$ of the grooves in an area along a line at the rotational position ϕ is set as

$$h_\phi = \frac{\lambda_0}{2(\cos\alpha + \cos\beta)\cos\phi}].$$

15. (Amended) The plane diffraction grating producing method according to claim 14, wherein the surface of the plane diffraction grating is then covered with a multiple-layer coating to improve reflectivity, and:

[an] a unit thickness $db[0]_{\underline{\phi}}$ of the multiple-layer coating in the area along the [original] line at the [rotational position $\varphi = 0$] azimuthal angle ϕ satisfies the equation

$$m_b \lambda_{[0]} = d_{b[0]\underline{\phi}}(R_{\alpha[0]\underline{\phi}} \sin\alpha + R_{\beta[0]\underline{\phi}} \sin\beta),$$

where

mb is the diffraction order,

$$R_{\alpha[0]\underline{\phi}} = \sqrt{1 - (2\delta_\phi - \delta_\phi{}^2)/\cos^2\alpha},\quad R_{\beta[0]\underline{\phi}} = \sqrt{1 - (2\delta_\phi - \delta_\phi{}^2)/\cos^2\beta},$$

$\delta = 1 - n_{\underline{\phi}}$,

where $n_{\underline{\phi}}$ is the average refractive index of the multiple-layer coating[,

and

an unit thickness $d_{b\varphi}$ of the multiple-layer coating in the area along the line at the rotational position ϕ satisfies the equation

$$m_b\lambda = d_{b\phi}(R_{\alpha\phi}\sin\alpha + R_{\beta\phi}\sin\beta),$$

where

λ is the wavelength of the light diffracted by the area

$$R_{\alpha\phi} = \sqrt{1-(2\delta_\phi - \delta^2{}_\phi)/\cos^2\alpha}\ ,\quad R_{\beta\phi} = \sqrt{1-(2\delta_\phi - \delta_\phi^2)/\cos^2\beta}\ ,$$

where $\delta_\varphi = 1\ n\phi$ and

$n\phi$ is the average refractive index of the multiple-layer coating].